

CAMBRIDGE UNIVERSITY PRESS

London: FETTER LANE, E.C.

C. F. CLAY, MANAGER.



Edinburgh: 100, PRINCES STREET

Berlin: A. ASHER AND CO.

Leipzig: F. A. BROCKHAUS

New York: G. P. PUTNAM'S SONS

Bombay and Calcutta: MACMILLAN AND CO., LTD.

All rights reserved



Charles Darwin

from a photograph by Maull & Sea

... circ. 1854

DARWIN AND MODERN SCIENCE

ESSAYS IN COMMEMORATION OF THE CENTENARY
OF THE BIRTH OF CHARLES DARWIN AND OF THE
FIFTIETH ANNIVERSARY OF THE PUBLICATION OF
THE ORIGIN OF SPECIES

EDITED, FOR THE CAMBRIDGE PHILOSOPHICAL SOCIETY
AND THE SYNDICS OF THE UNIVERSITY PRESS,

BY
A. C. SEWARD

PROFESSOR OF BOTANY IN THE UNIVERSITY
HONORARY FELLOW OF EMMANUEL COLLEGE

Cambridge :
at the University Press
1910

REFACE

AT the suggestion of the Cambridge Philosophical Society, the Syndics of the University Press decided in March, 1908, to arrange for the publication of a series of Essays in commemoration of the Centenary of the birth of Charles Darwin and of the Fiftieth anniversary of the publication of *The Origin of Species*. The preliminary arrangements were made by a committee consisting of the following representatives of the Council of the Philosophical Society and of the Press Syndicate: Dr H. K. Anderson, Prof. Bateson, Mr Francis Darwin, Dr Hobson, Dr Marr, Prof. Sedgwick, Mr David Sharp, Mr Shipley, Prof. Sorley, Prof. Seward. In the course of the preparation of the volume, the original scheme and list of authors have been modified: a few of those invited to contribute essays were, for various reasons, unable to do so, and some alterations have been made in the titles of articles. For the selection of authors and for the choice of subjects, the committee are mainly responsible, but for such share of the work in the preparation of the volume as usually falls to the lot of an editor I accept full responsibility.

Authors were asked to address themselves primarily to the educated layman rather than to the expert. It was hoped that the publication of the essays would serve the double purpose of illustrating the far-reaching influence of Darwin's work on the progress of knowledge and the present attitude of original investigators and thinkers towards the views embodied in Darwin's works.

In regard to the interpretation of a passage in *The Origin of Species* quoted on page 71, it seemed advisable to add an editorial footnote; but, with this exception, I have not felt it necessary to record any opinion on views stated in the essays.

In reading the essays in proof I have availed myself freely of the willing assistance of several Cambridge friends, among whom I wish more especially to thank Mr Francis Darwin for the active interest he has taken in the preparation of the volume. Mrs J. A. Thomson kindly undertook the translation of the essays by Prof. Weismann and Prof. Schwalbe ; Mrs James Ward was good enough to assist me by translating Prof. Bouglé's article on Sociology, and to Mr McCabe I am indebted for the translation of the essay by Prof. Haeckel. For the translation of the botanical articles by Prof. Goebel, Prof. Klebs and Prof. Strasburger, I am responsible ; in the revision of the translation of Prof. Strasburger's essay Madame Errera of Brussels rendered valuable help. Mr Wright, the Secretary of the Press Syndicate, and Mr Waller, the Assistant Secretary, have cordially cooperated with me in my editorial work ; nor can I omit to thank the readers of the University Press for keeping watchful eyes on my shortcomings in the correction of proofs.

The two portraits of Darwin are reproduced by permission of Messrs Maull and Fox and Messrs Elliott and Fry. The photogravure of the study at Down is reproduced from an etching by Mr Axel Haig, lent by Mr Francis Darwin ; the coloured plate illustrating Prof. Weismann's essay was originally published by him in his *Vorträge über Descendenztheorie* which afterwards appeared (1904) in English under the title *The Evolution Theory*. Copies of this plate were supplied by Messrs Fischer of Jena.

The Syndics of the University Press have agreed, in the event of this volume being a financial success, to hand over the profits to a University fund for the endowment of biological research.

It is clearly impossible to express adequately in a single volume of Essays the influence of Darwin's contributions to knowledge on the subsequent progress of scientific inquiry. As Huxley said in 1885 : "Whatever be the ultimate verdict of posterity upon this or that opinion which Mr Darwin has propounded ; whatever adumbrations or anticipations of his doctrines may be found in the writings of his predecessors ; the broad fact remains that, since the publication and by reason of the publication of *The Origin of Species* the funda-

mental conceptions and the aims of the students of living Nature have been completely changed.... But the impulse thus given to scientific thought rapidly spread beyond the ordinarily recognised limits of Biology. Psychology, Ethics, Cosmology were stirred to their foundations, and *The Origin of Species* proved itself to be the fixed point which the general doctrine needed in order to move the world."

In the contributions to this Memorial Volume, some of the authors have more especially concerned themselves with the results achieved by Darwin's own work, while others pass in review the progress of research on lines which, though unknown or but little followed in his day, are the direct outcome of his work.

The divergence of views among biologists in regard to the origin of species and as to the most promising directions in which to seek for truth is illustrated by the different opinions of contributors. Whether Darwin's views on the *modus operandi* of evolutionary forces receive further confirmation in the future, or whether they are materially modified, in no way affects the truth of the statement that, by employing his life "in adding a little to Natural Science," he revolutionised the world of thought. Darwin wrote in 1872 to Alfred Russel Wallace: "How grand is the onward rush of science: it is enough to console us for the many errors which we have committed, and for our efforts being overlaid and forgotten in the mass of new facts and new views which are daily turning up." In the onward rush, it is easy for students convinced of the correctness of their own views and equally convinced of the falsity of those of their fellow-workers to forget the lessons of Darwin's life. In his autobiographical sketch, he tells us, "I have steadily endeavoured to keep my mind free so as to give up any hypothesis, however much beloved...as soon as facts are shown to be opposed to it." Writing to Mr J. Scott, he says, "It is a golden rule, which I try to follow, to put every fact which is opposed to one's preconceived opinion in the strongest light. Absolute accuracy is the hardest merit to attain, and the highest merit. Any deviation is ruin."

He acted strictly in accordance with his determination expressed in a letter to Lyell in 1844, "I shall keep out of controversy, and just

give my own facts." As was said of another son of Cambridge, Sir George Stokes, "He would no more have thought of disputing about priority, or the authorship of an idea, than of writing a report for a company promoter." Darwin's life affords a striking confirmation of the truth of Hazlitt's aphorism, "Where the pursuit of truth has been the habitual study of any man's life, the love of truth will be his ruling passion." Great as was the intellect of Darwin, his character, as Huxley wrote, was even nobler than his intellect.

A. C. SEWARD.

BOTANY SCHOOL, CAMBRIDGE,
March 20, 1909.

CONTENTS

	PAGE
I. Introductory Letter to the Editor from SIR JOSEPH DALTON HOOKER, O.M.	1
II. Darwin's Predecessors : J. ARTHUR THOMSON, Professor of Natural History in the University of Aberdeen?	3
III. The Selection Theory : AUGUST WEISMANN, Professor of Zoology in the University of Freiburg (Baden)	18
IV. Variation : HUGO DE VRIES, Professor of Botany in the Uni- versity of Amsterdam	66
V. Heredity and Variation in Modern Lights : W. BATESON, Professor of Biology in the University of Cambridge	85
VI. The Minute Structure of Cells in Relation to Heredity : EDUARD STRASBURGER, Professor of Botany in the University of Bonn	102
VII. "The Descent of Man" : G. SCHWALBE, Professor of Anatomy in the Uni- versity of Strassburg	112
VIII. Charles Darwin as an Anthropologist : ERNST HAECKEL, Professor of Zoology in the University of Jena	137
IX. Some Primitive Theories of the Origin of Man : J. G. FRAZER, Fellow of Trinity College, Cambridge	152

Contents

	PAGE
X. The Influence of Darwin on the Study of Animal Embryology: A. SEDGWICK, Professor of Zoology and Comparative Anatomy in the University of Cambridge	171
XI. The Palaeontological Record. I. Animals: W. B. SCOTT, Professor of Geology in the University of Princeton	185
XII. The Palaeontological Record. II. Plants: D. H. SCOTT, President of the Linnean Society of London	200
XIII. The Influence of Environment on the Forms of Plants: GEORG KLEBS, Professor of Botany in the University of Heidelberg	223
XIV. Experimental Study of the Influence of Environment on Animals: JACQUES LOEB, Professor of Physiology in the University of California	247
XV. The Value of Colour in the Struggle for Life: E. B. POULTON, Hope Professor of Zoology in the University of Oxford	271
XVI. Geographical Distribution of Plants: Sir WILLIAM THISELTON-DYER	298
XVII. Geographical Distribution of Animals: HANS GADOW, Strickland Curator and Lecturer on Zoology in the University of Cambridge.	319
XVIII. Darwin and Geology: J. W. JUDD	337
XIX. Darwin's work on the Movements of Plants: FRANCIS DARWIN.	385
XX. The Biology of Flowers: K. GOEBEL, Professor of Botany in the University of Munich	401
XXI. Mental Factors in Evolution: C. LLOYD MORGAN, Professor of Psychology at University College, Bristol	424

XXII.	The Influence of the Conception of Evolution on Modern Philosophy : *	
	II. HÖFFDING, Professor of Philosophy in the University of Copenhagen	446
XXIII.	Darwinism and Sociology :	
	C. BOUGLÉ, Professor of Social Philosophy, in the University of Toulouse, and Deputy-Professor at the Sorbonne, Paris	465
XXIV.	The Influence of Darwin upon Religious Thought :	
	Rev. P. N. WAGGETT	477
XXV.	The Influence of Darwinism on the Study of Religions :	
	JANE ELLEN HARRISON, Staff-Lecturer and sometime Fellow of Newnham College, Cambridge	494
XXVI.	Evolution and the Science of Language :	
	P. GILES, Reader in Comparative Philology in the University of Cambridge	512
XXVII.	Darwinism and History :	
	J. B. BURY, Regius Professor of Modern History in the University of Cambridge	529
XXVIII.	The Genesis of Double Stars :	
	Sir GEORGE DARWIN, Plumian Professor of Astronomy and Experimental Philosophy in the University of Cambridge	543
XXIX.	The Evolution of Matter :	
	W. C. D. WHETHAM, Fellow of Trinity College, Cambridge	565
INDEX		583

LIST OF ILLUSTRATIONS

FRONTISPIECE. Portrait of Charles Darwin (1854) from a photograph by Messrs Maul & Fox, previously reproduced in *More Letters of Charles Darwin* and in the *Annals of Botany*, XIII. 1899, as the frontispiece of an article "The Botanical Work of Darwin," by Francis Darwin.

Plate illustrating *Anaea divina* . . . Facing page 53

Plate from Professor Weismann's *Vorträge über Descendenztheorie*, illustrating Mimicry in Butterflies . . . Facing page 57

The study at Down, from an etching by Mr Axel Haig . . . Facing page 379

Portrait of Charles Darwin (1880) from a photograph by Messrs Elliott & Fry . . . Facing page 493

DATES OF THE PUBLICATION OF CHARLES DARWIN'S BOOKS AND OF THE PRINCIPAL EVENTS IN HIS LIFE

- 1809 Charles Darwin born at Shrewsbury, February 12.*
- 1817 "At 8½ years old I went to Mr Case's school." [A day-school at Shrewsbury kept by the Rev. G. Case, Minister of the Unitarian Chapel.]
- 1818 "I was at school at Shrewsbury under a great scholar, Dr Butler; I learnt absolutely nothing, except by amusing myself by reading and experimenting in Chemistry."
- 1825 "As I was doing no good at school, my father wisely took me away at a rather earlier age than usual, and sent me (Oct. 1825) to Edinburgh University with my brother, where I stayed for two years."
- 1828 Began residence at Christ's College, Cambridge.
 "I went to Cambridge early in the year 1828, and soon became acquainted with Professor Henslow....Nothing could be more simple, cordial and unpretending than the encouragement which he afforded to all young naturalists."
 "During the three years which I spent at Cambridge my time was wasted, as far as the academical studies were concerned, as completely as at Edinburgh and at school."
 "In order to pass the B.A. Examination, it was...necessary to get up Paley's 'Evidences of Christianity,' and his 'Moral Philosophy.'...The careful study of these works, without attempting to learn any part by rote, was the only part of the academical course which...was of the least use to me in the education of my mind."
- 1831 Passed the examination for the B.A. degree in January and kept the following terms.
 "I gained a good place among the *οἱ πολλοί* or crowd of men who do not go in for honours."
 "I am very busy,...and see a great deal of Henslow, whom I do not know whether I love or respect most."
 Dec. 27. "Sailed from England on our circumnavigation," in H barque of 235 tons carrying 8 guns, under Capt. FitzRoy.
 "There is indeed a tide in the affairs of men."

- 1836 Oct. 4. "Reached Shrewsbury after absence of 5 years and 2 days."
 "You cannot imagine how gloriously delightful my first visit was at home; it was worth the banishment."
 Dec. 13. Went to live at Cambridge (Fitzwilliam Street).
 "The only evil I found in Cambridge was its being too pleasant."
- 1837 "On my return home [in the *Beagle*] in the autumn of 1836 I immediately began to prepare my journal for publication, and then saw how many facts indicated the common descent of species....In July (1837) I opened my first note-book for facts in relation to the Origin of Species, about which I had long reflected, and never ceased working for the next twenty years....Had been greatly struck from about the month of previous March on character of South American fossils, and species on Galapagos Archipelago. Those facts (especially latter), origin of all my views."
 "On March 7, 1837 I took lodgings in [36] Great Marlborough Street in London, and remained there for nearly two years, until I was married."
- 1838 "In October, that is fifteen months after I had begun my systematic enquiry, I happened to read for amusement 'Malthus on Population,' and being well prepared to appreciate the struggle for existence which everywhere goes on from long continued observation of the habits of animals and plants, it at once struck me that under these circumstances favourable variations would tend to be preserved, and unfavourable ones to be destroyed. The result of this would be the formation of new species. Here then I had at last got a theory by which to work; but I was so anxious to avoid prejudice, that I determined not for some time to write even the briefest sketch of it."
- 1839 Married at Maer (Staffordshire) to his first cousin Emma Wedgwood, daughter of Josiah Wedgwood.
 "I marvel at my good fortune that she, so infinitely my superior in every single moral quality, consented to be my wife. She has been my wise adviser and cheerful comforter throughout life, which without her would have been during a very long period a miserable one from ill-health. She has earned the love of every soul near her" [Autobiography].
 Dec. 31. "Entered 12 Upper Gower street" [now 110 Gower street; London].
 "There never was so good a house for me, and I devoutly trust you [his future wife] will approve of it equally. The little garden is worth its weight in gold."
 Published *Journal and Researches*, being Vol. III. of the *Narrative of the Surveying Voyage of H.M.S. Adventure and Beagle*....
 Publication of the *Zoology of the Voyage of H.M.S. Beagle*, Part II., *Mammalia*, by G. R. Waterhouse, with a *Notice of their habits and ranges*, by Charles Darwin.
- 1840 Contributed Geological Introduction to Part I. (*Fossil Mammalia*) of the *Zoology of the Voyage of H.M.S. Beagle* by Richard Owen.

1842 "In June 1842 I first allowed myself the satisfaction of writing a very brief abstract of my [species] theory in pencil in 35 pages; and this was enlarged during the summer of 1844 into one of 230 pages, which I had fairly copied out and still [1876] possess¹."

Sept. 14. Settled at the village of Down in Kent.

"I think I was never in a more perfectly quiet country."

- 1860 Publication of the second edition of the *Origin* (3000 copies).
Publication of a *Naturalist's Voyage*.
- 1861 Publication of the third edition of the *Origin* (2000 copies).
"I am going to write a little book...on Orchids, and to-day I hate them worse than everything."
- 1862 Publication of the book *On the various contrivances by which Orchids are fertilised by Insects*.
- 1865 Read paper before the Linnean Society "On the Movements and Habits of Climbing plants." (Published as a book in 1875.)
- 1866 Publication of the fourth edition of the *Origin* (1250 copies).
- 1868 "I have sent the MS. of my big book, and horribly, disgustingly big it will be, to the printers."
Publication of the *Variation of Animals and Plants under Domestication*.
"About my book, I will give you [Sir Joseph Hooker] a bit of advice. Skip the whole of Vol. I, except the last chapter, (and that need only be skimmed), and skip largely in the 2nd volume; and then you will say it is a very good book."
"Towards the end of the work I give my well-abused hypothesis of Pangenesis. An unverified hypothesis is of little or no value; but if anyone should hereafter be led to make observations by which some such hypothesis could be established, I shall have done good service, as an astonishing number of isolated facts can be thus connected together and rendered intelligible."
- 1869 Publication of the fifth edition of the *Origin*.
- 1871 Publication of *The Descent of Man*.
"Although in the *Origin of Species* the derivation of any particular species is never discussed, yet I thought it best, in order that no honourable man should accuse me of concealing my views, to add that by the work 'light would be thrown on the origin of man and his history'."
- 1872 Publication of the sixth edition of the *Origin*.
Publication of *The Expression of the Emotions in Man and Animals*.
- 1874 Publication of the second edition of *The Descent of Man*.
"The new edition of the *Descent* has turned out an awful job. It took me ten days merely to glance over letters and reviews with criticisms and new facts. It is a devil of a job."
Publication of the second edition of *The Structure and Distribution of Coral Reefs*.
- 1875 Publication of *Insectivorous Plants*.
"I begin to think that every one who publishes a book is a fool."
Publication of the second edition of *Variation in Animals and Plants*.
Publication of *The Movements and Habits of Climbing Plants* as a separate book.
- 1876 Wrote Autobiographical Sketch (*Life and Letters*, Vol. I., Chap. II.).
Publication of *The Effects of Cross and Self fertilisation*.
"I now [1881] believe, however, that I ought to have insisted more strongly than I did on the many adaptations for self-fertilisation."
Publication of the second edition of *Observations on Volcanic Islands*. *

- 1877 Publication of *The Different Forms of Flowers on Plants of the same species*.
 "I do not suppose that I shall publish any more books....I cannot endure being idle, but heaven knows whether I am capable of any more good work."
 Publication of the second edition of the Orchid book. •
- 1878 Publication of the second edition of *The Effects of Cross and Self-fertilisation*.
- 1879 Publication of an English translation of Ernst Krause's *Erasmus Darwin*, with a notice by Charles Darwin. "I am *extremely* glad that you approve of the little 'Life' of our Grandfather, for I have been repenting that I ever undertook it, as the work was quite beyond my tether." [To Mr Francis Galton, Nov. 14, 1879.]
- 1880 Publication of *The Power of Movement in Plants*.
 "It has always pleased me to exalt plants in the scale of organised beings."
 Publication of the second edition of *The Different Forms of Flowers*.
- 1881 Wrote a continuation of the Autobiography.
 Publication of *The Formation of Vegetable Mould, through the Action of Worms*.
 "It is the completion of a short paper read before the Geological Society more than forty years ago, and has revived old geological thoughts....As far as I can judge it will be a curious little book." •
- 1882 Charles Darwin died at Down, April 19, and was buried in Westminster Abbey, April 26, in the north aisle of the Nave a few feet from the grave of Sir Isaac Newton.
 "As for myself, I believe that I have acted rightly in steadily following and devoting my life to Science. I feel no remorse from having committed any great sin, but have often and often regretted that I have not done more direct good to my fellow creatures."

The quotations in the above Epitome are taken from the Autobiography and published Letters:—

The Life and Letters of Charles Darwin, including an Autobiographical Chapter Edited by his son, Francis Darwin, 3 Vols., London, 1887.

Charles Darwin: His life told in an Autobiographical Chapter, and in a selected series of his published Letters. Edited by his son, Francis Darwin, London, 1902.

More Letters of Charles Darwin. A record of his work in a series of hitherto unpublished Letters. Edited by Francis Darwin and A. C. Seward, 2 Vols., London, 1903.

“My success as a man of science, whatever this may have amounted to, has been determined, as far as I can judge, by complex and diversified mental qualities and conditions. Of these, the most important have been—the love of science—unbounded patience in long reflecting over any subject—industry in observing and collecting facts—and a fair share of invention as well as of common sense. With such moderate abilities as I possess, it is truly surprising that I should have influenced to a considerable extent the belief of scientific men on some important points.”

Autobiography (1881); *The Life and Letters of Charles Darwin*, Vol. I. p. 107.

FROM SIR JOSEPH DALTON HOOKER,
O.M., G.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S., ETC.

THE CAMP,
near SUNNINGDALE,
January 15, 1909.

DEAR PROFESSOR SEWARD,

The publication of a Series of Essays in Commemoration of the century of the birth of Charles Darwin and of the fiftieth anniversary of the publication of "The Origin of Species" is assuredly welcome and is a subject of congratulation to all students of Science.

These Essays on the progress of Science and Philosophy as affected by Darwin's labours have been written by men known for their ability to discuss the problems which he so successfully worked to solve. They cannot but prove to be of enduring value, whether for the information of the general reader or as guides to investigators occupied with problems similar to those which engaged the attention of Darwin.

The essayists have been fortunate in having for reference the five published volumes of Charles Darwin's Life and Correspondence. For there is set forth in his own words the inception in his mind of the problems, geological, zoological and botanical, hypothetical and theoretical, which he set himself to solve and the steps by which he proceeded to investigate them with the view of correlating the phenomena of life with the evolution of living things. In his letters he expressed himself in language so lucid and so little burthened with technical terms that they may be regarded as models for those who were asked to address themselves primarily to the educated reader rather than to the expert.

I may add that by no one can the perusal of the Essays be more vividly appreciated than by the writer of these lines. It was my privilege for forty years to possess the intimate friendship of Charles

Introductory Letter

Darwin and to be his companion during many of his working hours in Study, Laboratory, and Garden. I was the recipient of letters from him, relating mainly to the progress of his researches, the copies of which (the originals are now in the possession of his family) cover upwards of a thousand pages of foolscap, each page containing, on an average, three hundred words.

That the editorship of these Essays has been entrusted to a Cambridge Professor of Botany must be gratifying to all concerned in their production and in their perusal, recalling as it does the fact that Charles Darwin's instructor in scientific methods was his lifelong friend the late Rev. J. S. Henslow at that time Professor of Botany in the University. It was owing to his recommendation that his pupil was appointed Naturalist to H.M.S. *Beagle*, a service which Darwin himself regarded as marking the dawn of his scientific career.

Very sincerely yours,

J. D. HOOKER.

II

DARWIN'S PREDECESSORS

BY J. ARTHUR THOMSON.

Professor of Natural History in the University of Aberdeen.

IN seeking to discover Darwin's relation to his predecessors it is useful to distinguish the various services which he rendered to the theory of organic evolution.

(I) As everyone knows, the general idea of the Doctrine of Descent is that the plants and animals of the present-day are the lineal descendants of ancestors on the whole somewhat simpler, that these again are descended from yet simpler forms, and so on backwards towards the literal "Protozoa" and "Protophyta" about which we unfortunately know nothing. Now no one supposes that Darwin originated this idea, which in rudiment at least is as old as Aristotle. What Darwin did was to make it current intellectual coin. He gave it a form that commended itself to the scientific and public intelligence of the day, and he won wide-spread conviction by showing with consummate skill that it was an effective formula to work with, a key which no lock refused. In a scholarly, critical, and pre-eminently fair-minded way, admitting difficulties and removing them, foreseeing objections and forestalling them, he showed that the doctrine of descent supplied a modal interpretation of how our present-day fauna and flora have come to be.

(II) In the second place, Darwin applied the evolution-idea to particular problems, such as the descent of man, and showed what a powerful organon it is, introducing order into masses of uncorrelated facts, interpreting enigmas both of structure and function, both bodily and mental, and, best of all, stimulating and guiding further investigation. But here again it cannot be claimed that Darwin was original. The problem of the descent or ascent of man, and other particular cases of evolution, had attracted not a few naturalists before Darwin's day, though no one [except Herbert Spencer in the psychological domain (1855)] had come near him in precision and thoroughness of inquiry.

(III) In the third place, Darwin contributed largely to a knowledge of the factors in the evolution-process, especially by his analysis

of what occurs in the case of domestic animals and cultivated plants, and by his elaboration of the theory of Natural Selection, which Alfred Russel Wallace independently stated at the same time, and of which there had been a few previous suggestions of a more or less vague description. It was here that Darwin's originality was greatest, for he revealed to naturalists the many different forms—often very subtle—which natural selection takes, and with the insight of a disciplined scientific imagination he realised what a mighty engine of progress it has been and is.

(IV) As an epoch-marking contribution, not only to *Ætiology* but to *Natural History* in the widest sense, we rank the picture which Darwin gave to the world of the web of life, that is to say, of the inter-relations and linkages in Nature. For the *Biology* of the individual—if that be not a contradiction in terms—no idea is more fundamental than that of the correlation of organs, but Darwin's most characteristic contribution was not less fundamental,—it was the idea of the correlation of organisms. This, again, was not novel; we find it in the works of naturalists like Christian Conrad Sprengel, Gilbert White, and Alexander von Humboldt, but the realisation of its full import was distinctively Darwinian.

As Regards the General Idea of Organic Evolution.

While it is true, as Prof. H. F. Osborn puts it, that “‘Before and after Darwin’ will always be the *ante et post urbem conditam* of biological history,” it is also true that the general idea of organic evolution is very ancient. In his admirable sketch *From the Greeks to Darwin*¹, Prof. Osborn has shown that several of the ancient philosophers looked upon Nature as a gradual development and as still in process of change. In the suggestions of Empedocles, to take the best instance, there were “four sparks of truth,—first, that the development of life was a gradual process; second, that plants were evolved before animals; third, that imperfect forms were gradually replaced (not succeeded) by perfect forms; fourth, that the natural cause of the production of perfect forms was the extinction of the imperfect².” But the fundamental idea of one stage giving origin to another was absent. As the blue *Ægean* teemed with treasures of beauty and threw many upon its shores, so did Nature produce like a fertile artist what had to be rejected as well as what was able to survive, but the idea of one species emerging out of another was not yet conceived.

¹ *Columbia University Biological Series*, Vol. 1. New York and London, 1894. We must acknowledge our great indebtedness to this fine piece of work.

² *op. cit.* p. 41.

Aristotle's views of Nature¹ seem to have been more definitely evolutionist than those of his predecessors, in this sense, at least, that he recognised not only an ascending scale, but a genetic series from polyp to man and an age-long movement towards perfection. "It is due to the resistance of matter to form that Nature can only rise by degrees from lower to higher types." "Nature produces those things which, being continually moved by a certain principle contained in themselves, arrive at a certain end."

To discern the outcrop of evolution-doctrine in the long interval between Aristotle and Bacon seems to be very difficult, and some of the instances that have been cited strike one as forced. Epicurus and Lucretius, often called poets of evolution, both pictured animals as arising directly out of the earth, very much as Milton's lion long afterwards pawed its way out. Even when we come to Bruno who wrote that "to the sound of the harp of the Universal Apollo (the World Spirit), the lower organisms are called by stages to higher, and the lower stages are connected by intermediate forms with the higher," there is great room, as Prof. Osborn points out², for difference of opinion as to how far he was an evolutionist in our sense of the term.

The awakening of natural science in the sixteenth century brought the possibility of a concrete evolution theory nearer, and in the early seventeenth century we find evidences of a new spirit—in the embryology of Harvey and the classifications of Ray. Besides sober naturalists there were speculative dreamers in the sixteenth and seventeenth centuries who had at least got beyond static formulae, but, as Professor Osborn points out³, "it is a very striking fact, that the basis of our modern methods of studying the Evolution problem was established not by the early naturalists nor by the speculative writers, but by the Philosophers." He refers to Bacon, Descartes, Leibnitz, Hume, Kant, Lessing, Herder, and Schelling. "They alone were upon the main track of modern thought. It is evident that they were groping in the dark for a working theory of the Evolution of life, and it is remarkable that they clearly perceived from the outset that the point to which observation should be directed was not the past but the present mutability of species, and further, that this mutability was simply the variation of individuals on an extended scale."

Bacon seems to have been one of the first to think definitely about

¹ See G. J. Romanes, "Aristotle as a Naturalist," *Contemporary Review*, Vol. LIX, p. 275, 1891; G. Pouchet, *La Biologie Aristotélique*, Paris, 1885; E. Zeller, *A History of Greek Philosophy*, London, 1881, and "Ueber die griechischen Vorgänger Darwin's," *Abhandl. Berlin Akad.* 1878, pp. 111-124.

² *op. cit.* p. 81.

³ *op. cit.* p. 87.

the mutability of species, and he was far ahead of his age in his suggestion of what we now call a Station of Experimental Evolution. Leibnitz discusses in so many words how the species of animals may be changed and how intermediate species may once have linked those that now seem discontinuous. "All natural orders of beings present but a single chain".... "All advances by degrees in Nature, and nothing by leaps." Similar evolutionist statements are to be found in the works of the other "philosophers," to whom Prof. Osborn refers, who were, indeed, more scientific than the naturalists of their day. It must be borne in mind that the general idea of organic evolution—that the present is the child of the past—is in great part just the idea of human history projected upon the natural world, differentiated by the qualification that the continuous "Becoming" has been wrought out by forces inherent in the organisms themselves and in their environment.

A reference to Kant¹ should come in historical order after Buffon, with whose writings he was acquainted, but he seems, along with Herder and Schelling, to be best regarded as the culmination of the evolutionist philosophers—of those at least who interested themselves in scientific problems. In a famous passage he speaks of "the agreement of so many kinds of animals in a certain common plan of structure"...an "analogy of forms" which "strengthens the supposition that they have an actual blood-relationship, due to derivation from a common parent." He speaks of "the great Family of creatures, for as a Family we must conceive it, if the above-mentioned continuous and connected relationship has a real foundation." Prof. Osborn alludes to the scientific caution which led Kant, biology being what it was, to refuse to entertain the hope "that a Newton may one day arise even to make the production of a blade of grass comprehensible, according to natural laws ordained by no intention." As Prof. Haeckel finely observes, Darwin rose up as Kant's Newton².

The scientific renaissance brought a wealth of fresh impressions and some freedom from the tyranny of tradition, and the twofold stimulus stirred the speculative activity of a great variety of men from old Claude Duret of Moulins, of whose weird transformism

¹ See Brock, "Die Stellung Kant's zur Deszendenztheorie," *Biol. Centralbl.* viii. 1889, pp. 641—648. Fritz Schultze, *Kant und Darwin*, Jena, 1875.

² Mr Alfred Russel Wallace writes: "We claim for Darwin that he is the Newton of natural history, and that, just so surely as that the discovery and demonstration by Newton of the law of gravitation established order in place of chaos and laid a sure foundation for all future study of the starry heavens, so surely has Darwin, by his discovery of the law of natural selection and his demonstration of the great principle of the preservation of useful variations in the struggle for life, not only thrown a flood of light on the process of development of the whole organic world, but also established a firm foundation for all future study of nature" (*Darwinism*, London, 1889, p. 9). See also Prof. Karl Pearson's *Grammar of Science* (2nd edit.), London, 1900, p. 32. See Osborn, *op. cit.* p. 100.

(1609) Dr Henry de Varigny¹ gives us a glimpse, to Lorenz Oken (1779—1851) whose writings are such mixtures of sense and nonsense that some regard him as a far-seeing prophet and others as a fatuous follower of intellectual will-o'-the-wisps. Similarly, for De Maillet, Maupertuis, Diderot, Bonnet, and others, we must agree with Professor Osborn that they were not actually in the main Evolution movement. Some have been included in the roll of honour on very slender evidence, Robinet for instance, whose evolutionism seems to us extremely dubious².

The first naturalist to give a broad and concrete expression to the evolutionist doctrine of descent was Buffon (1707—1788), but it is interesting to recall the fact that his contemporary Linnæus (1707—1778), protagonist of the counter-doctrine of the fixity of species³, went the length of admitting (in 1782) that new species might arise by intercrossing. Buffon's position among the pioneers of the evolution-doctrine is weakened by his habit of vacillating between his own conclusions and the orthodoxy of the Sorbonne, but there is no doubt that he had a firm grasp of the general idea of "l'enchaînement des êtres."

Erasmus Darwin (1731—1802), probably influenced by Buffon, was another firm evolutionist, and the outline of his argument in the *Zoonomia*⁴ might serve in part at least to-day. "When we revolve in our minds the metamorphoses of animals, as from the tadpole to the frog; secondly, the changes produced by artificial cultivation, as in the breeds of horses, dogs, and sheep; thirdly, the changes produced by conditions of climate and of season, as in the sheep of warm climates being covered with hair instead of wool, and the hares and partridges of northern climates becoming white in winter: when, further, we observe the changes of structure produced by habit, as seen especially in men of different occupations; or the changes produced by artificial mutilation and prenatal influences, as in the crossing of species and production of monsters; fourth, when we observe the essential unity of plan in all warm-blooded animals,—we are led to conclude that they have been alike produced from a similar living filament"...."From thus meditating upon the minute portion of time in which many of the above changes have been produced, would it be too bold to imagine, in the great length of time since the earth began to exist, perhaps millions of years before the commence-

¹ *Experimental Evolution*. London, 1892. Chap. i. p. 14.

² See J. Arthur Thomson, *The Science of Life*. London, 1899. Chap. xvi. "Evolution of Evolution Theory."

³ See Carus Sterne (Ernst Krause), *Die allgemeine Weltanschauung in ihrer historischen Entwicklung*. Stuttgart, 1899. Chapter entitled "Beständigkeit oder Veränderlichkeit der Naturwesen."

⁴ *Zoonomia, or the Laws of Organic Life*, 2 vols. London, 1794; Osborn, *op. cit.* p. 145.

ment of the history of mankind, that all warm-blooded animals have arisen from one living filament?"... "This idea of the gradual generation of all things seems to have been as familiar to the ancient philosophers as to the modern ones, and to have given rise to the beautiful hieroglyphic figure of the *πρῶτον ὄόν*, or first great egg, produced by night, that is, whose origin is involved in obscurity, and animated by *Ἔρως*, that is, by Divine Love; from whence proceeded all things which exist."

Lamarck (1744—1829) seems to have become an evolutionist independently of Erasmus Darwin's influence, though the parallelism between them is striking. He probably owed something to Buffon, but he developed his theory along a different line. Whatever view be held in regard to that theory there is no doubt that Lamarck was a thorough-going evolutionist. Professor Haeckel speaks of the *Philosophie Zoologique* as "the first connected and thoroughly logical exposition of the theory of descent¹."

Besides the three old masters, as we may call them, Buffon, Erasmus Darwin, and Lamarck, there were other quite convinced pre-Darwinian evolutionists. The historian of the theory of descent must take account of Treviranus whose *Biology or Philosophy of Animate Nature* is full of evolutionary suggestions; of Étienne Geoffroy St Hilaire, who in 1830, before the French Academy of Sciences, fought with Cuvier, the fellow-worker of his youth, an intellectual duel on the question of descent; of Goethe, one of the founders of morphology and the greatest poet of Evolution—who, in his eighty-first year, heard the tidings of Geoffroy St Hilaire's defeat with an interest which transcended the political anxieties of the time; and of many others who had gained with more or less confidence and clearness a new outlook on Nature. It will be remembered that Darwin refers to thirty-four more or less evolutionist authors in his Historical Sketch, and the list might be added to. Especially when we come near to 1858 do the numbers increase, and one of the most remarkable, as also most independent champions of the evolution-idea before that date was Herbert Spencer, who not only marshalled the arguments in a very forcible way in 1852, but applied the formula in detail in his *Principles of Psychology* in 1855².

It is right and proper that we should shake ourselves free from all creationist appreciations of Darwin, and that we should recognise the services of pre-Darwinian evolutionists who helped to make the time ripe, yet one cannot help feeling that the citation of them is apt to suggest two fallacies. It may suggest that Darwin simply entered into

¹ See Alpheus S. Packard, *Lamarck, the Founder of Evolution, His Life and Work, with Translations of his writings on Organic Evolution*. London, 1901.

² See Edward Clodd, *Pioneers of Evolution*, London, p. 161, 1897.

the labours of his predecessors, whereas, as a matter of fact, he knew very little about them till after he had been for years at work. To write, as Samuel Butler did, "Buffon^o planted, Erasmus Darwin and